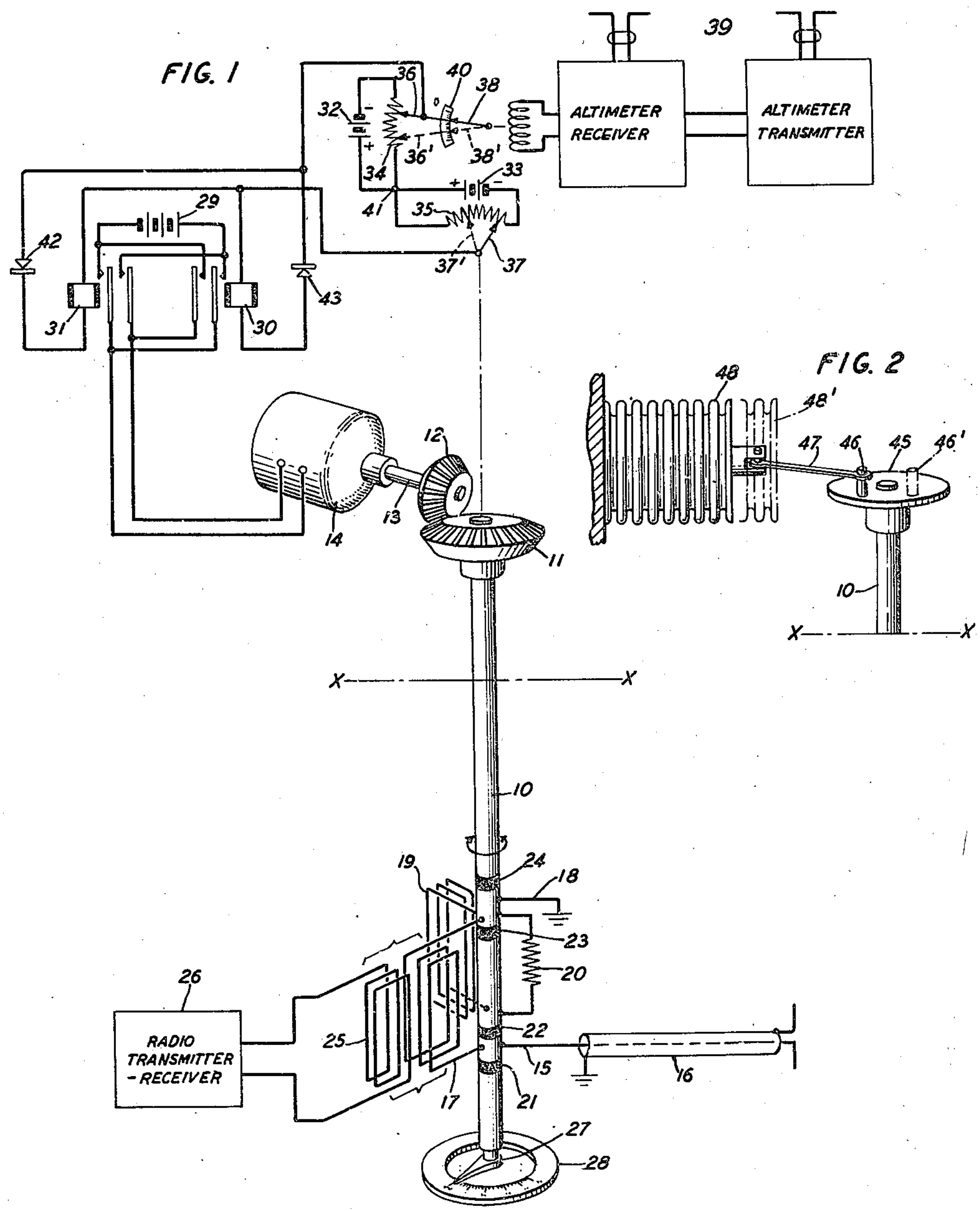
Dec. 13, 1949 D. MITCHELL 2,491,276

RADIO TRANSMISSION CONTROL

Filed April 20, 1948 2 Sheets-Sheet 1



INVENTOR
D. MITCHELL
BY
G. H. Heydt
ATTORNEY

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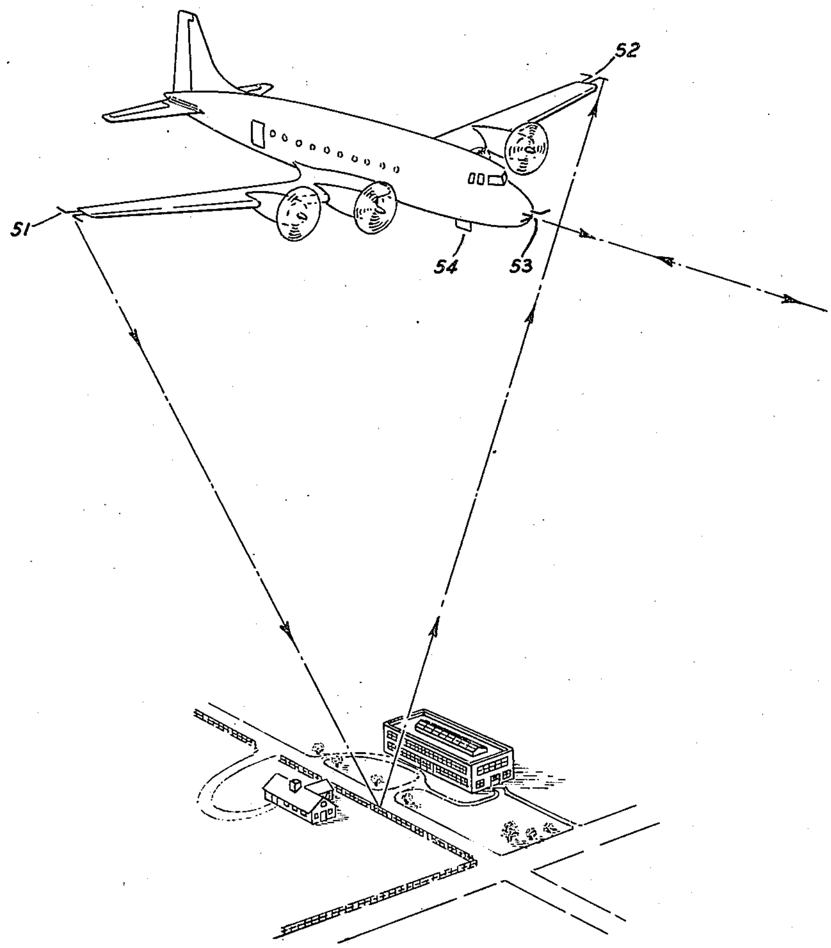
FIG. 3



INVENTOR
D. MITCHELL
BY
G. H. Heydt
ATTORNEY

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RADIO TRANSMISSION CONTROL

Doren Mitchell, Martinsville, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

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9 Claims. (Cl. 250—17)

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This invention relates to radio systems and in particular to systems and methods of controlling the propagation and reception ranges of radio waves.

It is an object of this invention to obtain in an aircraft radio system a constant transmitting range.

It is another object of this invention to obtain in a radio system a constant transmitting range irrespective of the height of said system.

It is a further object of this invention to obtain in an aircraft radio system, comprising a transmitter connected to an antenna, a constant transmission range without varying the power output of said transmitter.

It is a still further object of this invention to control the range of a mobile radio transmitter-receiver system in accordance with the altitude of said system.

It is an additional object of this invention to control the energy radiated by an antenna in accordance with the height of said antenna.

Other objects and uses of the invention will be apparent from a study of the specification and drawings.

It is known that the propagation and reception ranges of radio systems may be determined by varying the power output of these systems. Control systems have been developed to regulate transmission and reception ranges and while these systems are usually efficient in operation they also have inherent limitations. When, for example, mobile radio systems are used in airplanes it may be desirable to limit the transmission and reception of the radio system to a twenty-mile range in order to minimize interference. If a one hundred watt transmitter operating at one hundred and fifty megacycles is used in an airplane the transmitter will have an effective range of about twenty miles when the airplane containing the transmitter is situated on the ground. However, as the airplane rises from the ground the transmitter range increases fairly rapidly to a range of about two hundred miles, at an altitude of twenty thousand feet, and this expanded range may be an undesirable feature. In the future, due to the rapid development of the mobile radio art and the resultant extensive use of mobile radio systems by increasing numbers of people, the extension of the transmission and reception ranges of a radio system may result in unwanted crosstalk and other interferences. The invention maintains a substantially constant range in a radio system by effectively limiting the radio system transmission-reception distances in

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accordance with the altitudes of the radio system radiating and receiving members.

In the preferred embodiment of the invention the control of a radio system transmission and/or reception range is varied automatically in accordance with the height of the system transmitting-receiving members in relation to the earth. In the invention an automatic coupling system may vary the radiated power output of a radio transmitter, or the power input of a radio receiver, in response to variations in the altitude of the transmitting or receiving antennae. In an alternative embodiment of the invention the automatic coupling system responds to variations in the pressures of the atmosphere.

Referring to the drawings:

Fig. 1 is a schematic drawing of an embodiment of the invention and shows equipment for automatically controlling the ranges of a transmitter-receiver radio system in accordance with variations in altitude;

Fig. 2 is a schematic drawing of an alternative embodiment of the system shown in Fig. 1, and shows equipment for automatically controlling the ranges of a transmitter-receiver radio system in accordance with variations in atmospheric pressures; and

Fig. 3 is a schematic drawing and shows the control system of Fig. 1 and/or Fig. 2 utilized in an airplane.

Referring to Fig. 1 which is a schematic drawing of an embodiment of the invention, a shaft 10, adapted for rotative movement in clockwise or counter-clockwise directions, may be actuated through connecting gears 11 and 12 by a drive shaft 13 which may be motivated by a reversible motor 14. The shaft 10 has an antenna connection 15 from an antenna 16, an antenna pick-up loop 17, a ground connection 18, and an absorption loop 19 with which is connected a dissipation resistance 20. The equipment units 15, 17, 18, 19 and 20 are electrically divided as illustrated by insulated segments 21, 22, 23, and 24 of the shaft 10. Positioned for inductive coupling to the pick-up loop 17, or to the absorption loop 19, is a loop 25 which is connected to a radio transmitter-receiver 26. Secured to an end of the shaft 10 is a position indicating pointer 27. The pointer 27 turns with the shaft 10 and moves over a chart 28, which may be calibrated in angles of degrees, so that the position of the pointer 27 in relation to the chart 28 may inform an observer at any instant of the angular position of the shaft 10.

The reversible motor 14 may be energized from an electromotive source 29 through operated contacts of a relay 30, or may be energized to rotate in an opposite direction through the operated contacts of a relay 31. The motor 14 may be so connected that operation of the relay 30 actuates the motor 14 in a counter-clockwise direction and the motor 14 acting upon the shaft 10, through the gears 11 and 12, turns the shaft 10 in a clockwise direction, while operation of the relay 31 may cause the motor 14 to turn the shaft 10 in a counter-clockwise direction. The operation circuits of the relays 30 and 31 are controlled from electromotive sources 32 and 33 through potentiometers 34 and 35, and through potentiometer slider arms 36 and 37. The voltage potential across the electromotive source 32 is preferably equal to the voltage potential across the electromotive source 33, and the resistances of the potentiometers 34 and 35 should also be of equal value.

The potentiometer slider arm 37 is mechanically connected to the shaft 10 and movement of the shaft 10 moves the potentiometer slider arm 37 in a corresponding direction. The potentiometer slider arm 36 is connected to an indication needle 38 of an electronic altimeter system 39. Movement of the indicator 38 upon an altimeter indicating dial 40 results in a movement of the potentiometer slider arm 36 in a corresponding direction. The electronic altimeter system 39 may be of a type known in the art such as that system disclosed in Patent 2,247,662 issued July 1, 1941 to R. C. Newhouse.

The system embodiment in accordance with the invention operates as follows. Suppose that the system is installed as a part of a mobile radio system in an airplane. When the airplane is situated on the ground the antenna pick-up loop 17 will be positioned for optimum inductive coupling to the radio transmitter-receiver loop 25. When the pick-up loop 17 is so situated, the potential between a point 41 and the tip of the potentiometer slider arm 36 will equal the potential between the point 41 and the tip of the potentiometer slider arm 37. Since these potentials oppose each other there is no potential difference between the tips of the slider arms 36 and 37, and no current will flow from these tips through the relay energizing circuits. When the airplane rises into the air and has attained a certain altitude the electronic altimeter needle 38 will have moved to a new position 38′ in relation to the altimeter indicator dial 40, and will have moved the potentiometer slider arm 36 to a new position 36′. When the slider arm 36 occupies the new position 36′ the potential between the point 41 and the tip of the slider arm 36 in position 36′ will be less than the potential between the point 41 and the tip of the slider arm 37, and current will flow to the tip of the slider arm 36 and thence through a circuit, including a unidirectional conducting valve 42, to energize and operate the relay 31. Operation of the relay 31 energizes the motor 14 so that the shaft 10 turns in a counter-clockwise direction as discussed. The counter-clockwise movement of the shaft 10 swings the antenna pick-up loop 17 away from the transmitter-received loop 25, so as to reduce the coupling between the loop 17 and the loop 25, and at the same time swings the absorption loop 19 into a more favorable coupling position so as to increase the coupling between the loop 19 and the transmitter-receiver loop 25. This action diverts a portion of the energy from the radio transmitter-receiver 26 into the absorption loop 19 and prevents some of this energy portion from reaching the antenna 16, for some of the energy diverted into the absorption loop 19 is dissipated in the resistance 20. The use of the absorption loop provides range control of the mobile radio system, equalizes the load on the transmitter and facilitates the tuning of the transmitter.

As the shaft 10 turns in a counter-clockwise direction the slider arm 37 turns with the shaft 10 until it reaches a new position 37′. When the slider arm 37 has reached the position 37′ the voltage potential between the point 41 and the tip of slider arm 36 in position 36′ will equal the voltage potential between the point 41 and the tip of the slider arm 37 in position 37′. Since these potentials opposed each other there is no potential difference between the tips of the slider arms 36 and 37 in positions 36′ and 37′, and no current will flow to the relay energizing circuit and the relay 31 will restore to a normal non-operated condition and stop the movement of the motor 14. When the motor 14 stops, the turning movement of the shaft 10 ceases and the shaft 10 comes to rest with the loops 17 and 19 retaining their new positions in relationship to the transmitter-receiver loop 25.

When the airplane loses altitude the altimeter needle 38 will move back from the position 38′ towards the zero position on the altimeter dial 40 until it reaches a position at which it will indicate the new altitude of the airplane in relationship to the earth. The backward movement of the needle 38 will move the slider arm 36 back from the position 36′ towards the position originally occupied by the slider arm 36 before altitude was attained. When the slider arm 36 occupies the new position the potential from the point 41 to the tip of the slider arm 37, in position 37′, will be less than the potential between the point 41 and the tip of the slider arm 36, and current will flow to energize and operate the relay 30 through a circuit including the slider arm 37 in position 37′, the relay 30, and a unidirectional conducting valve 43. Operation of the relay 30 actuates the motor 14 and causes the shaft 10 to turn in a clockwise direction as discussed. The shaft 10 when turning in a clockwise direction moves the absorption loop 19 away from the transmitter-receiver loop 25, and moves the antenna loop 17 into a better coupling position in relationship to the transmitter-receiver loop 25. The turning movement of the shaft 10 also moves the slider arm 37 back from the position 37′, towards the original position it occupied before the airplane attained altitudes, until the slider arm 37 reaches a point on the potentiometer 35 whereat the potential from the point 41 to the tip of the slider arm 36 is equal to the potential from the point 41 to the tip of the slider arm 37. When the condition of equal potentials is attained no current flows to the relay energizing circuits, the relay 30 will then restore to a normal non-operated position and the turning movement of the shaft 10 will cease.

It will be readily understood that while the system as shown utilizes one antenna for both transmission and reception purposes a plurality of antennae may be utilized. The automatic control features in accordance with the invention may also be utilized by the transmitter mechanism alone, while the receiver mechanism may operate normally and use a separate antenna without the automatic control feature.

Referring to Fig. 2, there is shown an alternate embodiment of the invention for automatically controlling the range of a radio system in accordance with variations in atmospheric pressures. Here is shown a disk 45 with a pin 46 attached to the disk. The disk 45 is adapted for connection to the coupling mechanism of Fig. 1 along the section marked "XX." The pin 46 is connected by a crank 47 to a bellows mechanism 48 which is preferably sealed at sea level atmospheric pressure. This equipment is adaptable for use in an airplane for controlling the coupling between the pick-up loop 17, the absorption loop 19 and the transmitter-receiver loop 25 of Fig. 1.

This system operates as follows. When the airplane is situated upon the ground the bellows 48 being subjected to ground level atmospheric pressure is in a normally contracted condition. When the airplane leaves the ground and gains altitude the atmospheric pressure decreases and the bellows mechanism expands and occupies a new position 48′. Expansion of the bellows acting through the crank 47 upon the pin 46 pushes the pin 46 to a new position 46′, and turns the shaft 10 in a counter-clockwise direction moving the pick-up loop 17 away from the transmitter-receiver loop 25, in a manner discussed in relation to Fig. 1. As the airplane loses altitude the bellows is compressed and contracts due to increased atmospheric pressure, and the pin 46 moves from the position 46′ back towards the original position it occupied when the airplane was situated on the ground, and moves the absorption loop 19 away from the transmitter-receiver loop 25, in a manner discussed in relation to Fig. 1.

Referring to Fig. 3 which is a schematic drawing showing the automatic range control systems of Figs. 1 and 2 utilized in an airplane, Fig. 3 shows antennae 51 and 52 of an electronic altimeter system corresponding to the antennas of the altimeter 39 of Fig. 1, and antenna 53 of a transmitter-receiver system corresponding to antenna 16 together with a bellows mechanism 54.

It is to be understood that the above-described embodiments are illustrative examples and that various modifications may be made without departing from the spirit of this invention.

What is claimed is:

1. In a mobile radio system, the combination of a transmitter, a radiating member, a dissipation member, separate adjustable rotatable elements for coupling said members to said transmitter, and means responsive to changes in atmospheric pressure for simultaneously rotating said elements in a clockwise or counter-clockwise direction dependent upon the sense of the change in said pressure, whereby the couplings of said members to said transmitter are varied in opposite senses upon any change in said pressure and the sense of the variation for each coupling is reversed upon a reversal in the sense of the change in said pressure.

2. The combination of claim 1 in which the responsive means is responsive to changes in the altitude of said radiating member.

3. In a mobile radio system the combination of, a transmitter-receiver, a radiating member, a dissipation member, movable coupling loops for coupling said members to said transmitter-receiver, and means responsive to changes in atmospheric pressure due to changes in altitude for varying the positions occupied by said loops in their relationships to said transmitter-receiver.

4. In a radio system the combination of a transmitter, a radiating member, a dissipation member, an adjustable coupling element included between said transmitter and said members and means responsive to changes in the altitude of said system for controlling the adjustment of said element.

5. In a mobile microwave radio system comprising a transmitter, a radiating member, a dissipative member, and separate adjustable elements coupling said members to said transmitter, the method comprising decreasing the coupling of said radiating member and simultaneously increasing the coupling of the dissipative member upon an increase in the altitude of said system, and increasing the coupling of said radiating member and simultaneously decreasing the coupling of said dissipative member upon a decrease in said altitude.

6. In a system for rendering the effective range of a radio system independent of the height of said system, the method comprising changing the amounts of energy emitted and received by said system inversely in accordance with changes in the height of said system.

7. In a system for maintaining constant the range of a mobile radio system irrespective of variations in the altitude of said radio system and without changing the power output of said radio system, the method comprising, radiating the entire output of said radio system when said radio system is situated at a minimum altitude, radiating a portion of said output and dissipating the remaining output portion when said radio system is situated at a different altitude, and progressively decreasing the ratio of said radiated portion to said dissipated portion as the altitude increases.

8. In a system for maintaining constant the range of a mobile radio system irrespective of changes in the altitude of said radio system and in the atmospheric pressures surrounding said system, and without changing the power of said radio system, the method comprising efficiently utilizing the power of said radio system when said radio is situated at a minimum altitude, efficiently utilizing a portion of said power and dissipating the remaining portion when said radio attains a different altitude, and progressively decreasing the ratio of said efficiently utilized power portion to said dissipated power portion as the altitude increases, while increasing said ratio as the altitude decreases.

9. The method of radio communication from an airborne vessel which comprises continuously measuring the height of the vessel above the earth's surface and continuously controlling the intensity of the radio frequency energy transmitted from the vessel for communication under control of the height indication to cause that energy to vary inversely with the height.

DOREN MITCHELL.

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